3.5 Loads

It is accepted in limit state philosophy that the loads in practice may vary from those initially assumed. Therefore the basic load is adjusted by a partial safety factor to give the ultimate design load. Each of these will be discussed in turn.

3.5.1. Characteristic loads

These are the basic loads that may be applicable to a particular member or structure and are defined as follows:

Characteristic dead load G_k The weight of the structure complete with finishes, fixtures and partitions, obtained from BS 648 'Schedule of weights of building materials'.

Characteristic imposed load Q_k The live load produced by the occupants and usage of the building, obtained from BS 6399 'Design loading for buildings', Part 1 for floors or Part 3 for roofs.

Characteristic wind load W_k The wind load acting on the structure, obtained from CP 3 Chapter V Part 2 'Wind loads', which will eventually become Part 2 of BS 6399.

3.5.2 Partial safety factors for load

In practice the applied load may be greater than the characteristic load for any of the following reasons:

(a) Calculation errors
(b) Constructional inaccuracies
(c) Unforeseen increases in load.

To allow for these the respective characteristic loads are multiplied by a partial safety factor γ_f to give the ultimate design load appropriate to the limit state being considered. That is,

$$\text{Ultimate design load} = \gamma_f \times \text{characteristic load}$$

Values of γ_f for various load combinations are given in BS 8110 Table 2.1, reproduced here as Table 3.1.

Table 3.1 Load combinations and values of γ_f for the ultimate limit state (BS 8110 Part 1 1985 Table 2.1)

Load combination	Dead load		Imposed load		Earth and water pressure	Wind load
	Adverse	Beneficial	Adverse	Beneficial		
Dead and imposed (and earth and water pressure)	1.4	1.0	1.6	0	1.4	—
Dead and wind (and earth and water pressure)	1.4	1.0	—	—	1.4	1.4
Dead and wind and imposed (and earth and water pressure)	1.2	1.2	1.2	1.2	1.2	1.2

3.5.3 Ultimate design load

The ultimate design load acting on a member will be the summation of the relevant characteristic load combinations multiplied by their respective partial safety factors. Thus the ultimate design load for the combination of dead and imposed loads would be expressed as follows:

$$\text{Ultimate design load } F \text{ dead + imposed} = \gamma_f G_k + \gamma_f Q_k$$
$$= 1.4G_k + 1.6Q_k$$

The following examples illustrate the computation of loads for limit state design. They may be compared with the examples in Chapter 1 for permissible stress design.

Example 3.1

A series of 400 mm deep × 250 mm wide reinforced concrete beams spaced at 5 m centres and spanning 7.5 m support a 175 mm thick reinforced concrete slab as shown in Figure 3.1. If the imposed floor loading is 3 kN/m^2 and the load induced by the weight of concrete is 24 kN/m^3, calculate the total ULS loading condition for the slab and the beams.

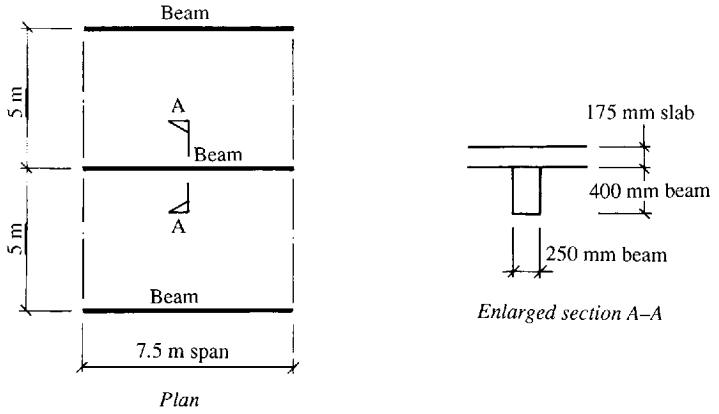

Figure 3.1 *Arrangement of beams*

Slab

The ULS loading condition for the slab will be the dead plus imposed combination:

Dead load G_k from 175 mm slab = 24 × 0.175 = 4.2 kN/m^2

Imposed load Q_k = 3 kN/m^2

Total ULS loading = $\gamma_f G_k + \gamma_f Q_k$ = 1.4 × 4.2 + 1.6 × 3 = 10.68 kN/m^2

Beam

The ULS loading condition for the beams will be a UDL consisting of the slab dead plus imposed combination together with the load due to the self-weight of